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Weizman et al.

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(54) **IDENTIFYING A SCRIPT THAT ORIGINATES SYNCHRONOUS AND ASYNCHRONOUS ACTIONS**

(71) Applicant: **PerimeterX, Inc.**, San Mateo, CA (US)

(72) Inventors: **Gal Weizman**, Tel Aviv (IL); **Itai Sadan**, Tel Aviv (IL)

(73) Assignee: **PERIMETERX, INC.**, San Mateo, CA (US)

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G06F 16/957	(2019.01)
G06F 9/54	(2006.01)
G06F 9/38	(2018.01)
G06F 16/958	(2019.01)

(52) **U.S. Cl.**

CPC ***G06F 16/9577*** (2019.01); ***G06F 9/3871*** (2013.01); ***G06F 9/541*** (2013.01); ***G06F 16/958*** (2019.01)

(58) **Field of Classification Search**

CPC .. G06F 16/9577; G06F 16/958; G06F 9/3871; G06F 9/541

See application file for complete search history.

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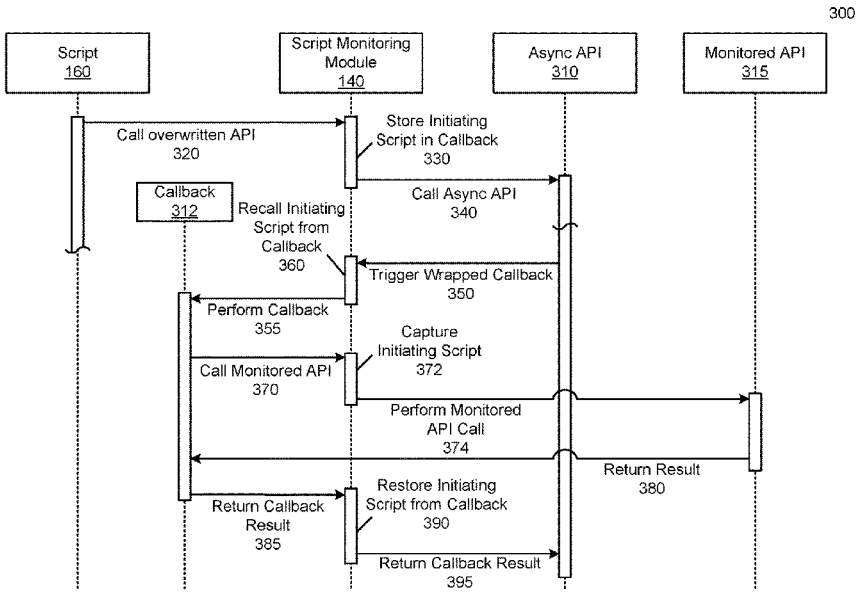
Primary Examiner — Hope C Sheffield
(74) *Attorney, Agent, or Firm* — SQUIRE PATTON BOGGS (US) LLP

(57) **ABSTRACT**

A browser can include a script monitoring module to monitor executing scripts and log the initiating scripts for API calls or other monitored actions. In some embodiments, the script monitoring module overwrites built-in or web APIs in the browser with versions of the APIs that allow the script monitoring module to identify the scripts calling the APIs. Using the script monitoring module, the script initiating an action (such as an API call) can be identified using features of the browser. In some embodiments, all actions may be monitored in this way, permitting the tracking and analysis of scripts and full analysis of interaction between such scripts on the webpage and with the browser.

19 Claims, 4 Drawing Sheets



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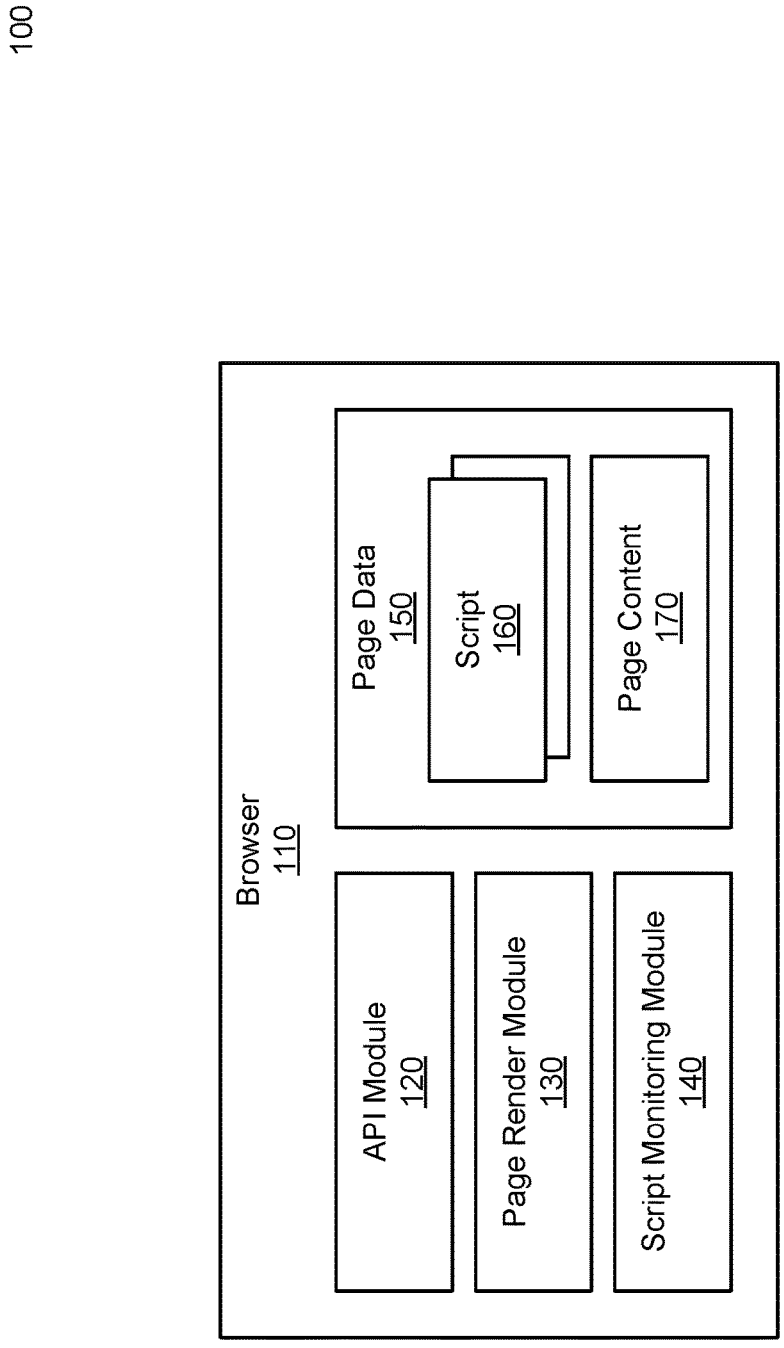
100
Browser
110
API Module
120
Page Render Module
130
Script Monitoring Module
140
Page Data
150
Script
160
Page Content
170

FIG. 1

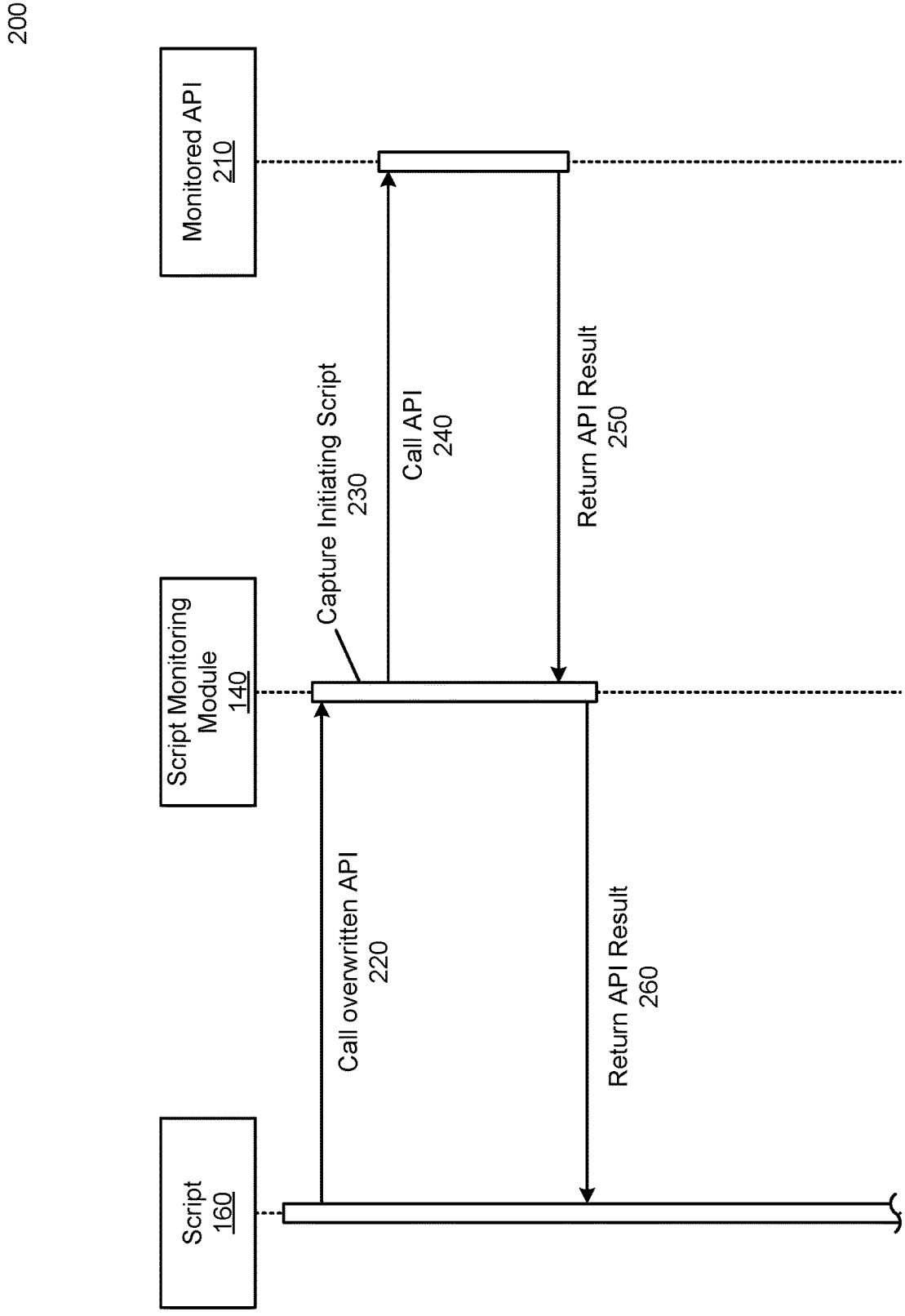
200
Monitored API
210
Script Monitoring Module
140
Script
160
Capture Initiating Script
230
Call API
240
Return API Result
250
Call overwritten API
220
Return API Result
260

FIG. 2

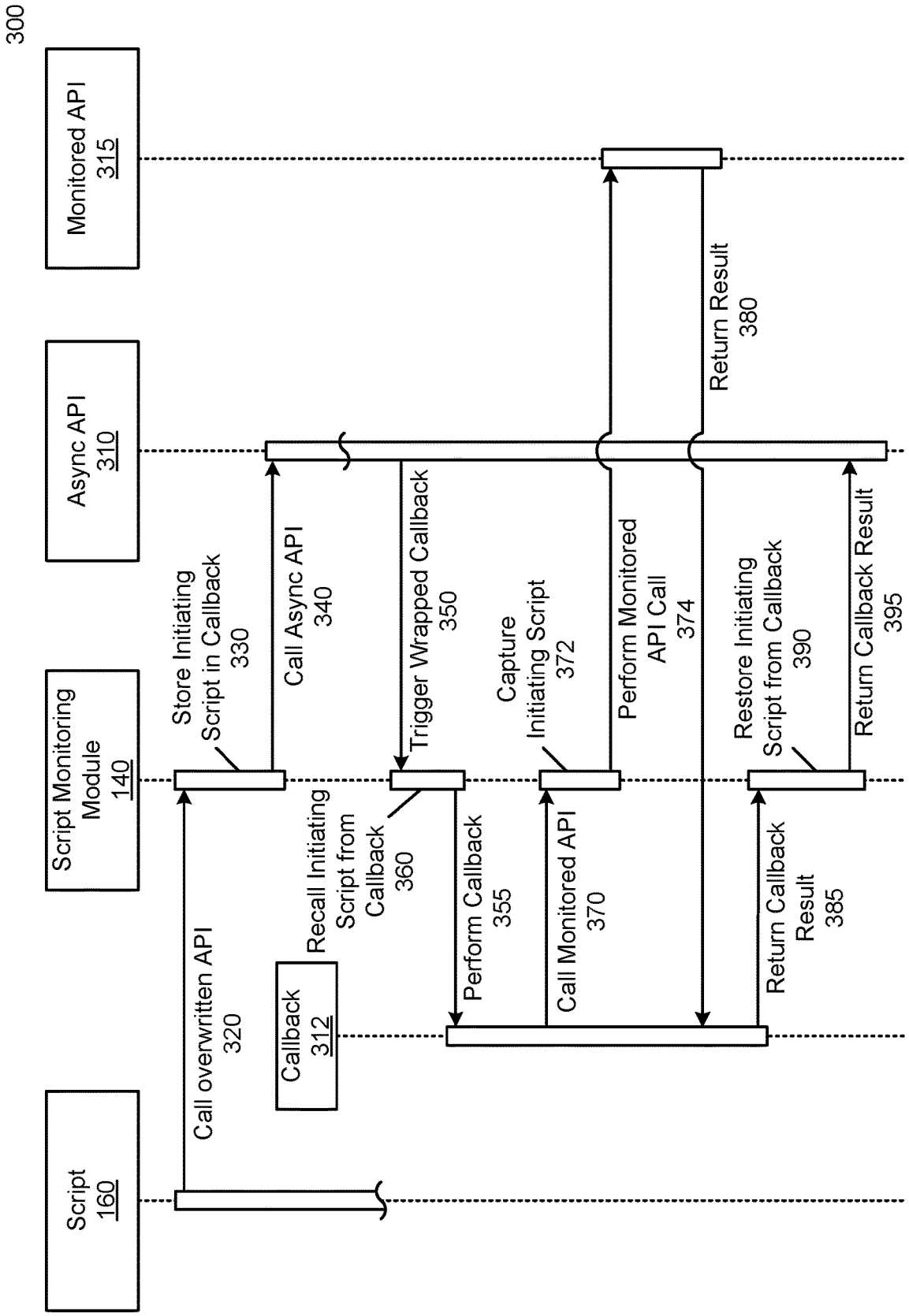
300
Monitored API 315
Async API 310
Script Monitoring Module 140
Script 160
Callback 312
Store Initiating Script in Callback 330
Call Async API 340
Trigger Wrapped Callback 350
Capture Initiating Script 372
Perform Monitored API Call 374
Return Result 380
Restore Initiating Script from Callback 390
Return Callback Result 395
Call overwritten API 320
Recall Initiating Script from Callback 360
Perform Callback 355
Call Monitored API 370
Return Callback Result 385

FIG. 3

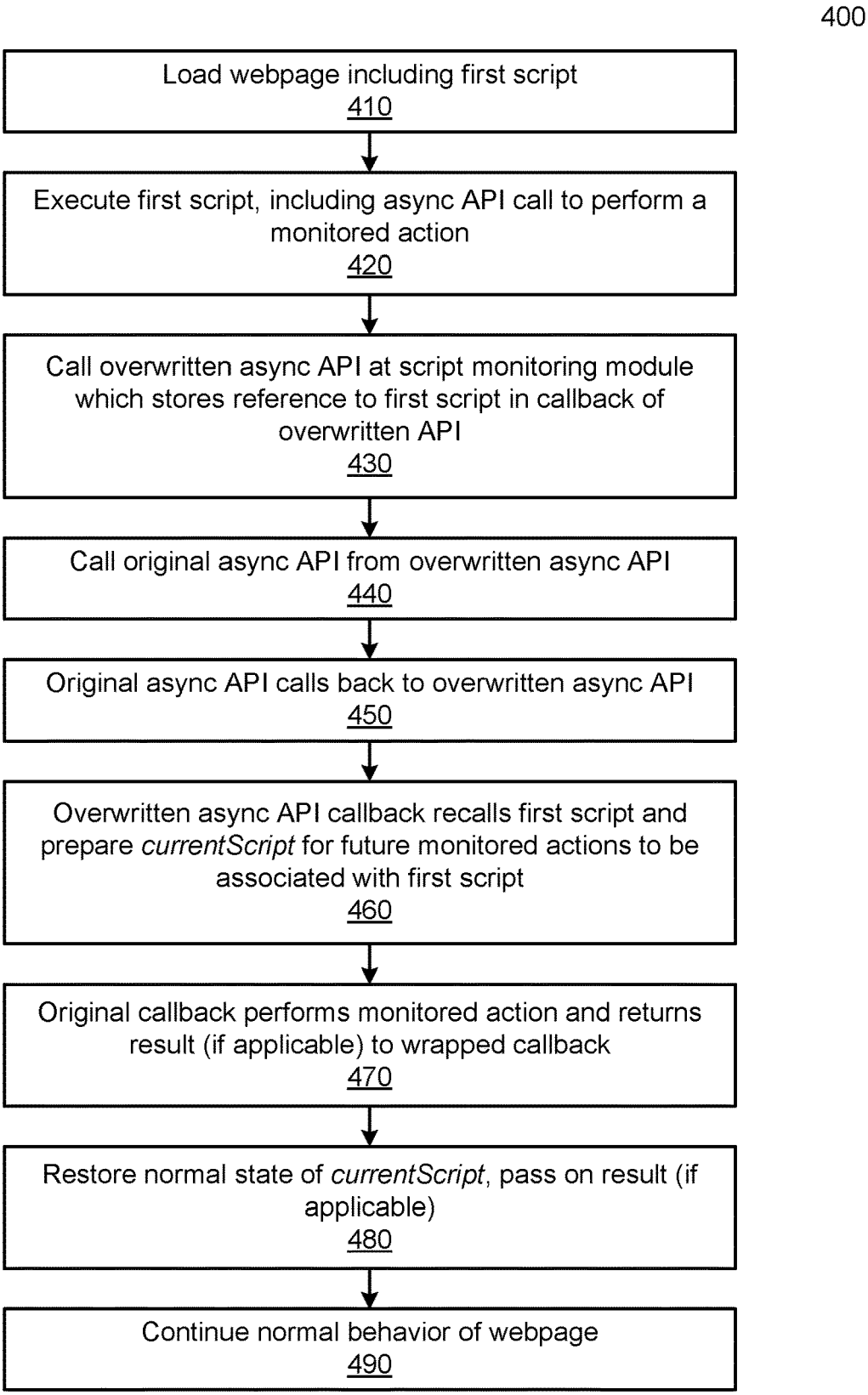
400
Load webpage including first script
410
Execute first script, including async API call to perform a monitored action
420
Call overwritten async API at script monitoring module which stores reference to first script in callback of overwritten API
430
Call original async API from overwritten async API
440
Original async API calls back to overwritten async API
450
Overwritten async API callback recalls first script and prepare currentScript for future monitored actions to be associated with first script
460
Original callback performs monitored action and returns result (if applicable) to wrapped callback
470
Restore normal state of currentScript, pass on result (if applicable)
480
Continue normal behavior of webpage
490

FIG. 4

IDENTIFYING A SCRIPT THAT ORIGINATES SYNCHRONOUS AND ASYNCHRONOUS ACTIONS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 62/891,532, filed Aug. 26, 2019, which is incorporated by reference in its entirety.

BACKGROUND

This disclosure generally relates to script monitoring in a browser environment and, in particular, to tracking a scripts initiated an API call.

Webpages loaded into a web browser can contain scripts in addition to the page content for display to the end user. Each script can take a variety of actions within the browser to modify displayed page content, gather data about the browser or computing device accessing the webpage, or the like. Additionally, scripts within a webpage can be from different sources (for example, when the webpage has content from multiple sources). However, web browsers have limited ability to track the initiating script of any given action or API call. Some inbuilt script monitoring functionality may exist (such as currentScript in Javascript), but it is limited and not directly applicable to all situations where script tracking can be useful.

SUMMARY

In order to monitor scripts, a browser can include a script monitoring module to monitor executing scripts and log the initiating scripts for API calls or other monitored actions. In some embodiments, the script monitoring module overwrites built-in or web APIs in the browser with versions of the APIs that allow the script monitoring module to identify the scripts calling the APIs. Using the script monitoring module, the script initiating an action (such as an API call) can be identified using features of the browser. In some embodiments, all actions may be monitored in this way, permitting the tracking and analysis of scripts and full analysis of interaction between such scripts on the webpage and with the browser.

Scripts may take a variety of actions within a browser, such that gathering information about which scripts take which actions can be useful to, for example, detect scripts initiating unexpected or unauthorized actions, track the performance impact of various scripts, or the like. A log of scripts generated by a script monitoring module can allow the webpage, locally executing JavaScript, or the browser to monitor everything that happens in the browser when visiting the webpage and the actions initiated by the webpage (and including those from scripts invoked by the webpage).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a system environment in which a script monitoring system operates, in accordance with an embodiment.

FIG. **2** is an interaction diagram illustrating a process for determining the initiating script for a monitored API call, according to an embodiment.

FIG. **3** is an interaction diagram illustrating a process for determining the initiating script for an asynchronous API call, according to an embodiment.

FIG. **4** is a flowchart illustrating a process for monitoring the initiating script for an asynchronous API call, according to an embodiment.

The figures depict various embodiments for purposes of illustration only. One skilled in the art will recognize that alternative embodiments of the structures and methods illustrated herein may be employed without departing from the principles described herein.

DETAILED DESCRIPTION

Overview

A script monitoring module incorporated into a browser can allow the browser to link a script in a currently loaded webpage to actions (such as a web API call) taking place in the browser initiated by the script. The script monitoring module can function for actions initiated synchronously or asynchronously by the initiating script. In some embodiments, the script monitoring module can overwrite built-in or web APIs in the browser with versions that allow the script monitoring module to identify the scripts that call the overwritten APIs. Using the script monitoring module, the script initiating an action (such as an API call) can be identified using features of the browser (for example, currentScript for JavaScript scripts). In some embodiments, all actions may be monitored in this way, permitting the tracking and analysis of scripts and full analysis of interaction between such scripts on the webpage and with the browser.

In some implementations, tracking certain asynchronous actions (such as actions initiated with a call to an asynchronous API) is more difficult than tracking synchronous actions. In some cases, asynchronous actions cannot be monitored using only the inbuilt tracking tools (such as currentScript) which may not support tracking the initiator of asynchronously executed code. Therefore, the script monitoring module can also overwrite asynchronous APIs in the browser to include additional functionality for detecting the current running script (at the time the asynchronous API was called) and storing the initiating script until the associated asynchronous callback is triggered.

Knowing which script has initiated what action on the webpage can useful to create a map of each action taking place in the webpage alongside an initiating script for each of these actions. This map (and analysis identifying the initiating scripts) may therefore allow the webpage, locally executing JavaScript, or the browser to monitor everything that happens in the browser when visiting the webpage and the actions initiated by the webpage (and including those from scripts invoked by the webpage).

System Architecture

FIG. **1** is a block diagram of a system environment in which a script monitoring system operates, in accordance with an embodiment. The system environment **100** of FIG. **1** comprises a browser **110** including an API module **120**, a page render module **130**, a script monitoring module **140**, and page data **150**. The page data **150** can include one or more scripts **160** and page content **170** for display.

The browser **110** can be a web browser or other program capable of retrieving and interpreting page data **150** for a webpage (or other source of content). In some embodiments the browser **110** operates on a client device such as a personal computer or smartphone and can generate a graphical user interface for display to a user of the client device based on received page data **150**. For example, the browser **110** can execute one or more scripts **160** of the page data and display page content **170** in the graphical user interface of

the browser **110** based on the results of the scripts **160**, gather, send, or store data on the client device based on the scripts **160**, or the like. In some implementations, the browser **110** supports scripts **160** in a language such as JavaScript and can execute the scripts **160** as the page data **150** is being rendered by the page render module **130**. In other implementations, the methods discussed herein can be used to monitor initiating scripts in other contexts, including in systems with no graphical display or scripts **160** from sources other than a webpage.

Through the API module **120**, the browser **110** can allow scripts **160** of the page data **150** to access one or more application program interfaces (APIs). APIs accessible through the API module **120** can be stored locally or accessed in any other suitable manner. In some implementations, a script **160** can access an API through an API call which identifies the API and (depending on the API) provides one or more arguments to the API to modify the behavior of the API. The API, on receiving the API call, can then execute one or more actions and, in some cases, provide a return value to the script **160**. As used herein, synchronous or "sync" APIs are APIs in the browser **110** that, when called with appropriate arguments, synchronously execute code to perform actions (for example, to calculate a value based on the provided arguments) and store and/or return a value to the script **160**, which continues executing based on the returned value. In some implementations, when executing a sync API call, the script **160** is still considered active on the browser **110** and the continued execution of the script **160** is conditional on the result of the API call. For example, the script **160** can wait until the sync API call is complete to execute the next line of code in the script **160**. Therefore, the API call is executed "synchronously" with the script **160**, as the API call and return value are performed in an expected sequence with the other actions of the script **160**, according to some embodiments.

Asynchronous or "async" APIs, as used herein, are APIs in the browser **110** that, when called, ask the browser **110** to execute a callback function when the async API detects that a trigger condition is met. As used herein, a callback function (or "callback") is code executed based on a trigger condition of an async API call and can be provided to the async API as an argument. In some implementations, the choice of async API (and some provided arguments) can set the trigger condition(s) defining the timing of a desired action, while the callback function (also provided as an argument) defines the desired action. A callback can include code, calls to other functions or APIs, or other actions. Therefore, after the initial API call, the execution of an async API is independent of (and executed asynchronously with) the execution of the script **160** calling the async API. Async APIs can trigger a callback for any reason (depending on the async API), for example, based on a certain event being observed or after a preset period of time. The callback associated with an async API call executes at the time the correct trigger conditions are met, and can trigger after the script **160** which originally called the async API has finished executing or is no longer active. In some embodiments, an API can exhibit a mixture of synchronous and asynchronous behavior depending, for example, on provided arguments or the specific situation when the API is called.

The page render module **130** can interpret received page data **150**, execute scripts **160** of the page data **150**, and generate a graphical user interface of the browser **110** for display based on the scripts **160** and page content **170** of the page data **150**. For example, the page render module **130** can execute one or more scripts **160** (which may contain API calls) and based on the returned values of the scripts **160**, obtain or select page content **170** to display in the graphical user interface.

The script monitoring module **140** can, in some embodiments, track and log an initiating script **160** for a set of monitored actions, such as API calls (or calls to a specific set of monitored APIs). As used herein, the initiating script for an API call is the script **160** which originally called the API. In the case of API calls involving an async API, the initiating script may be inactive at the time the callback of the async API is executed. In some implementations, the script monitoring module **140** uses a current script function (for example, JavaScript's document.currentScript, which holds a reference to the script that is currently being processed) to determine the active script **160** at the time an API call or other monitored action is being executed. For example, using the current script function during the execution of a sync API call will return the initiating script (which is currently active in the case of a sync API). However, trying to use a current script function during the callback of an async API call may not reliably work, as asynchronous JavaScript code executing in the browser **110** is not a script recognized by the current script function. For example, when the callback of an async API contains code to execute another monitored action (such as a call to a monitored API), current script functions can fail to return an active script. In these circumstances, using a current script function on the callback of an async API call will return a null reference when called inside a function (such as a monitored API call) that was called from an async API callback.

To enable monitoring actions called from async APIs, the script monitoring module **140** can overwrite one or more APIs to store or log the initiating script before executing the async API call. As used herein, an "overwrite" is the action of replacing an existing property or function in the browser with another (for example, an overwrite as supported in JavaScript). For example, an API function can be overwritten with a "wrapper" function which stores a reference to the initiating script before calling the original version of the API function with the appropriate arguments. In some implementations, when a script **160** calls for an API function, the wrapped version of the API function is instead called to enable monitoring by the script monitoring module **140**. The wrapped API function can then eventually call the original API function to preserve the functionality of the script **160**.

In some implementations (including embodiments using JavaScript), to enable monitoring of initiating script **160** during asynchronous actions, the script monitoring module **140** uses a closure (for example, as implemented by JavaScript) to store the initiating script **160** in an overwritten callback of async APIs. In JavaScript, a closure is a technique for linking a variable to a function (such as an async API callback) such that the function (when called) can access a previously set value of the variable. In some embodiments, a closure is used to associate the callback function of an async API with an indicator of the initiating script of the initial API call. In other implementations, a "bind" can similarly be used to store the initiating script for an async API call.

In some implementations, the page data **150** is code, content, or other data received for the browser **110** to display a webpage (or other source of content). The page data **150** can comprise one or more scripts **160**, which may be JavaScript functions or other code. As descried above, scripts **160** can call APIs and/or cause the browser **110** to take other monitored actions monitored by the script monitoring module **140**. Page content **170** can be text, graphical

content, video content, CSS, or HTML used by the page render module **130** to render a version of the webpage (or other content) for display to a user.

Initiating Script Determination for Synchronous APIs

FIG. **2** is an interaction diagram illustrating a process for determining the initiating script for a synchronous API call, according to an embodiment. The interaction diagram of FIG. **2** comprises a script **160** executing in the browser **110**, the script monitoring module **140**, and a sync API **210** which is a synchronous API of the API module **120** in the embodiment of FIG. **2**.

FIG. **2** discloses a process to determine the initiating script for an example synchronous API (referred to herein as "sync( )"). For example, sync( ) can be a monitored API monitored by the script monitoring module **140**. The sync( ) API can take one or more arguments and synchronously return some result. For example, sync( ) can receive an argument of the URL to a resource to fetch and return a value indicting if the retrieval was successful.

To keep track of which script **160** initiated the call to sync( ) the script monitoring module **140** can overwrite sync( ) in the browser **100**, for example based on the following logic:

```
let initiatorScript = null;
function getCurrentScript( ) {
  if (document.currentScript) {
    return document.currentScript;
  } else {
    // if there no script that is currently being processed -
    // then document.currentScript is null
    return initiatorScript;
  }
}
// hold a reference to the original sync API function
const realSyncAPI = window['sync'];
window['sync'] = function(url) {
  // use 'document.currentScript' to record which script
  // initiated the call to sync( )
  capture('sync', getCurrentScript( ) );
  // now call the original sync API to perform its natural
  // behavior in the browser as it was being overwritten
  return realSyncAPI(url);
};
```

Here, in the process of FIG. **2**, when a script **160** in the page **150** calls the sync( ) API through the browser **110**, actually the browser is calls **220** the overwritten version of the API. During the execution of the overwritten API at the script monitoring module **140**, the overwritten API captures **230** a reference to the initiating script **160** (for example, as a reference in a variable storing the initiating script). Then, to maintain the correct functionality of the monitored API **210** (here, sync( )), the original monitored API **210** is called **240** from within the overwritten API. After the monitored API **210** executes as normal the API result is returned **250**, first to the overwritten API at the script monitoring module **140** and then **260** passed through to the initiating script **160** for use. Therefore, using this process, the script monitoring module **140** can keep track of the initiating script **160** of the synchronous action while maintaining the functionality of the monitored API **210**.

Initiating Script Determination with Asynchronous APIs

However, determining the initiating script **160** for a given monitored action can be more complicated when async APIs are involved. If the monitored API is an async API, a process similar to the process described above can be used to track the initiating script. However, if a monitored API is called from within the callback of an async API (or even in during a chain of async APIs) the previously described process will not reliably work. In these cases, code (for example, JavaScript code) that is executed as part of a callback that was registered to be executed asynchronously by the browser **110** (for example, in the case of an async API) is not by default associated with the initiating script **160** that originally called the async API (as a different or no script **160** may be currently being executed depending on when the async API callback was triggered). Therefore, attempting to access the currentScript function (or other current script function) at the time the callback of the async API is being executed without employing additional techniques will result in a null result and leave the script monitoring module **140** without the ability to determine the initiating script from the callback alone.

FIG. **3** is an interaction diagram illustrating a process for determining the initiating script for an asynchronous API call, according to an embodiment. The interaction diagram of FIG. **3** comprises a script **160** executing in the browser **110**, the script monitoring module **140**, an async API **210** which is an asynchronous API of the API module **210** which triggers a callback **312**, and a monitored API **315** called by the asynchronous callback **312** of the async API **310** for which the initiating script **160** is tracked.

Therefore, the script monitoring module **140** can overwrite both the initial call to the async API **310** and the callback **312** of the async API **310** with wrapped versions including code that allows the script monitoring module **140** to keep track of the script **160** that initiated the asynchronous action as the callback **312** is executed. FIG. **3** discloses a process to determine the initiating script **160** for an example asynchronous API (referred to herein as "async( )") with an associated callback. For example, the async( ) API can receive arguments including a callback (such as another API call) and a number representing a wait time before executing the callback. To allow the callback of async( ) to be replaced with a wrapped version, the script monitoring module **140** can overwrite async( ) in the browser **100**, for example based on the following logic:

```
// hold a reference to the original async API function
const realAsyncAPI = window['async'];
window['async'] = function(callback, time) {
  // create a wrap for the provided callback to report the
  // initiating script and then call the original callback
  const wrappedCallback = getWrappedCallback(callback);
  // now call the real async API using the new wrapped callback as
  // an argument (instead of the original callback)
  return realAsyncAPI(wrappedCallback, time);
};
```

In some embodiments, the getWrappedCallback( ) function generates a wrapped callback (based on the original callback function) that also stores the initiating script **160** (for example, using a closure) for the wrapped callback to reference and report at the time the callback is executed. In some implementations, the callback is overwritten based on the following logic:

```
function getWrappedCallback(callback) {
  // save current script to a local variable
  const cs = getCurrentScript( );
  return function wrappedCallback( ) {
    // now the cs variable storing the initiating script is closured
      // into the wrappedCallback( ) function declared here
      // set the current script to the closured variable
      setCurrentScript(cs);
```

-continued

```
    // now that the currentScript is set, call the original callback
    const returnValue = callback.apply(this, arguments);
    // after original callback finished executing reset the current
      // script property back to the previous value, to preserve the
      // natural behavior of document.currentScript
    revertCurrentScript( );
  // return the return value of the callback
  return returnValue;
};
```

At this point in the process of FIG. **3**, when a script **160** of the page data **150** calls the async( ) API through the browser **110**, the script **160** is actually calling **320** the overwritten version of the async( ) API which generates a wrapped callback to replace the original callback **312**. As the overwritten async( ) executes, a local variable reference to the initiating script **160** is generated (for example, through the document.currentScript feature) and stored **330** into the wrapped callback (for example, using a JavaScript closure) of the overwritten async( ). Then, the original async API **310** is called **340** with arguments instructing it to call the wrapped callback (instead of the original callback **312**). The async API **310** continues execution normally and, at some point, triggers **350** the wrapped callback (executed at the script monitoring module **140**) responsive to a trigger condition being met. As noted above, in some cases, the script **160** is no longer active at the time the trigger condition is met and the callback is triggered **350**.

The wrapped callback function first recalls **360** the reference to the initiating script **160** previously stored (for example, using a closure) when the wrapped callback was generated and sets the stored initiating script **160** as the active script. For example, the wrapped callback can set a global holder variable of the current script referenced by currentScript to the initiating script **160**. Therefore, if called during the execution of the wrapped callback (and other code called from within the wrapped callback), the currentScript property will reference the initiating script **160**, even though the script **160** may not be active at this point. Next, the script monitoring module performs **355** the original callback **312** provided with the initial call to the async API. In some embodiments any monitored actions taken within the original callback **312** can be associated with the initiating script **160** using currentScript, as the wrapped callback has set the active script to the initiating script **160**.

In some implementations, the callback **312** calls **370** a monitored API **315**, which may also be overwritten to log (as described above) the initiating script **160**. As the currentScript property has be set to reference the initiating script **160**, the script monitoring module **140** and overwritten APIs will function as intended and record the initiating script **160** as initiating the monitored API call **370**. For example, if sync( ) is the monitored API **315** called within the callback of the async API **310**, the line:

```
const initiatorScript=getCurrentScript( );
```

will correctly capture **372** the initiating script **160** into this local variable before performing **374** the monitored API call. Therefore, using this process, getCurrentScript( ) retrieved a reference to the script **160** because of the overwritten version of async( ) (which preserves the current script before letting the browser **110** asynchronously continue the execution of the callback). If the wrapped async API was not used, any references to the currentScript variable may contain null or a reference to the wrong script (as the script **160** may not be the active script at the time the callback **312** is executed). After the monitored API **315** has finished executing and returned **380** a result to the callback **312** (and the callback **312** returns **385** the result to the wrapped callback at the script monitoring module **140**), the wrapped callback can restore **390** the currentScript variable to its previous value. In some embodiments, currentScript is reset to preserve the natural behavior of current script function in the browser **110** when not executing overwritten async APIs. In some implementations, no result is returned **380** (depending on the specific async API **310** and the monitored API **315**), but the wrapped callback still restores currentScript to its natural value prior to ending execution. Finally, the callback result can be returned **395** to the Async API **310**. Therefore, using this process, the script monitoring module **140** can keep track of the initiating script **160** of the asynchronous action while maintaining the functionality of the async API **310** and the use of currentScript outside async API calls.

FIG. **4** is a flowchart illustrating a process for monitoring the initiating script for an asynchronous API call, according to an embodiment. The process **400** begins when a browser loads **410** a webpage including a first script and begins to execute **420** the first script. In the embodiment of FIG. **4**, the first script includes a call to an async API with a callback including a monitored action. During the execution of the first script, the browser calls **430** an overwritten async API (in place of the original async API in the script) which then detects the first script as the initiating script and stores a reference to the first script in callback of the overwritten API. As described above, a script monitoring module can maintain overwritten version of async APIs to facilitate tracking an initiating script even for actions taken asynchronously. The overwritten API then calls **440** the original async API to perform the functions needed for the script. At some point later, the original async API's trigger condition is met and the original async API calls back **450** to the wrapped callback (the callback of the overwritten async API). During the execution of the wrapped callback, the overwritten async API callback recalls **460** the first script (for example, due to a closured variable), prepares for future monitored actions taken during the callback to be associated with first script (for example, by setting a currentScript property to reflect the first script), and calls the original callback of the API call. When the original callback performs **470** the monitored action, the browser can capture the association of the monitored action with the first script (due to the wrapped callback, as discussed above). The result (if applicable) of the original callback can then be passed to the wrapped callback, which restores **480** the natural value of any variables set to associate future actions with the first script (such as currentState) and further passes through any result of the original callback. Then, the browser continues **490** to present the webpage or execute further scripts.

CONCLUSION

The foregoing description of the embodiments has been presented for the purpose of illustration; it is not intended to be exhaustive or to limit the patent rights to the precise forms disclosed. Persons skilled in the relevant art can appreciate that many modifications and variations are possible in light of the above disclosure.

Some portions of this description describe the embodiments in terms of algorithms and symbolic representations of operations on information. These algorithmic descriptions and representations are commonly used by those skilled in the data processing arts to convey the substance of their work effectively to others skilled in the art. These operations, while described functionally, computationally, or logi-

cally, are understood to be implemented by computer programs or equivalent electrical circuits, microcode, or the like. Furthermore, it has also proven convenient at times, to refer to these arrangements of operations as modules, without loss of generality. The described operations and their associated modules may be embodied in software, firmware, hardware, or any combinations thereof.

Any of the steps, operations, or processes described herein may be performed or implemented with one or more hardware or software modules, alone or in combination with other devices. In one embodiment, a software module is implemented with a computer program product comprising a computer-readable medium containing computer program code, which can be executed by a computer processor for performing any or all of the steps, operations, or processes described.

Embodiments may also relate to an apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes, and/or it may comprise a general-purpose computing device selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a non-transitory, tangible computer readable storage medium, or any type of media suitable for storing electronic instructions, which may be coupled to a computer system bus. Furthermore, any computing systems referred to in the specification may include a single processor or may be architectures employing multiple processor designs for increased computing capability.

Embodiments may also relate to a product that is produced by a computing process described herein. Such a product may comprise information resulting from a computing process, where the information is stored on a non-transitory, tangible computer readable storage medium and may include any embodiment of a computer program product or other data combination described herein.

Finally, the language used in the specification has been principally selected for readability and instructional purposes, and it may not have been selected to delineate or circumscribe the patent rights. It is therefore intended that the scope of the patent rights be limited not by this detailed description, but rather by any claims that issue on an application based hereon. Accordingly, the disclosure of the embodiments is intended to be illustrative, but not limiting, of the scope of the patent rights, which is set forth in the following claims.

What is claimed is:

1. A method comprising:

loading, by a browser on a client device, a webpage comprising a set of scripts for execution by the browser;

executing, by the browser as part of executing a first script of the set of scripts, a call to a first asynchronous API comprising a set of arguments and a first callback function that is to be executed upon a trigger condition, the execution of the call to the first asynchronous API comprising:

calling an overwritten first asynchronous API using the set of arguments and the first callback function;

generating, by the overwritten first asynchronous API, a wrapped callback function comprising an identification of the first script and a call to the first callback function; and

calling, by the overwritten first asynchronous API, the first asynchronous API using the set of arguments and the wrapped callback function;

detecting, by the first asynchronous API, that the trigger condition is met; and

upon the detection of the trigger condition, executing by the first asynchronous API, the wrapped callback function comprising:

setting, by the wrapped callback function, a current script variable back to the first script based on the identification of the first script; and

executing the first callback function.

2. The method of claim **1**, further comprising restoring the current script variable to a previous value.

3. The method of claim **1**, wherein executing the first callback function comprises:

calling a first synchronous API;

referencing the current script variable to determine a current script; and

storing an association between the first script and the first synchronous API.

4. The method of claim **1**, wherein executing, by the first asynchronous API, the wrapped callback function occurs after execution of the first script has finished.

5. The method of claim **1**, wherein generating, by the overwritten first asynchronous API, a wrapped callback function comprising the identification of the first script and a call to the first callback function comprises using a closure to store a reference to the first script.

6. The method of claim **1**, wherein generating, by the overwritten first asynchronous API, a wrapped callback function comprising the identification of the first script and a call to the first callback function comprises using a bind to store a reference to the first script.

7. A non-transitory computer-readable storage medium comprising instructions which, when executed by a processor, cause the processor to perform the steps of:

loading, by a browser on a client device, a webpage comprising a set of scripts for execution by the browser;

executing, by the browser as part of executing a first script of the set of scripts, a call to a first asynchronous API comprising a set of arguments and a first callback function that is to be executed upon a trigger condition, the execution of the call to the first asynchronous API comprising:

calling an overwritten first asynchronous API using the set of arguments and the first callback function;

generating, by the overwritten first asynchronous API, a wrapped callback function comprising an identification of the first script and a call to the first callback function; and

calling, by the overwritten first asynchronous API, the first asynchronous API using the set of arguments and the wrapped callback function;

detecting, by the first asynchronous API, that the trigger condition is met; and

upon the detection of the trigger condition, executing, by the first asynchronous API, the wrapped callback function comprising:

setting, by the wrapped callback function, a current script variable back to the first script based on the identification of the first script; and

executing the first callback function.

8. The non-transitory computer-readable storage medium of claim **7**, wherein the steps further comprise the step of restoring the current script variable to a previous value.

9. The non-transitory computer-readable storage medium of claim **7**, wherein executing the first callback function comprises:

calling a first synchronous API;

referencing the current script variable to determine a current script; and

storing an association between the first script and the first synchronous API.

10. The non-transitory computer-readable storage medium of claim **7**, wherein executing, by the first asynchronous API, the wrapped callback function occurs after execution of the first script has finished.

11. The non-transitory computer-readable storage medium of claim **7**, wherein generating, by the overwritten first asynchronous API, a wrapped callback function comprising the identification of the first script and a call to the first callback function comprises using a closure to store a reference to the first script.

12. The non-transitory computer-readable storage medium of claim **7**, wherein generating, by the overwritten first asynchronous API, a wrapped callback function comprising the identification of the first script and a call to the first callback function comprises using a bind to store a reference to the first script.

13. A system comprising:

a processor; and

a non-transitory computer-readable storage medium comprising instructions which, when executed by the processor, cause the processor to perform the steps of:

loading, by a browser on a client device, a webpage comprising a set of scripts for execution by the browser;

executing, by the browser as part of executing a first script of the set of scripts, a call to a first asynchronous API comprising a set of arguments and a first callback function that is to be executed upon a trigger condition, the execution of the call to the first asynchronous API comprising:

calling an overwritten first asynchronous API using the set of arguments and the first callback function;

generating, by the overwritten first asynchronous API, a wrapped callback function comprising an identification of the first script and a call to the first callback function; and

calling, by the overwritten first asynchronous API, the first asynchronous API using the set of arguments and the wrapped callback function;

detecting, by the first asynchronous API, that the trigger condition is met; and

upon the detection of the trigger condition, executing by the first asynchronous API, the wrapped callback function comprising:

setting, by the wrapped callback function, a current script variable back to the first script based on the identification of the first script; and

executing the first callback function.

14. The system of claim **13**, wherein the steps further comprise the step of restoring the current script variable to a previous value.

15. The system of claim **13**, wherein executing the first callback function comprises:

calling a first synchronous API;

referencing the current script variable to determine a current script; and

storing an association between the first script and the first synchronous API.

16. The system of claim **13**, wherein executing, by the first asynchronous API, the wrapped callback function occurs after execution of the first script has finished.

17. The system of claim **13**, wherein generating, by the overwritten first asynchronous API, a wrapped callback function comprising the identification of the first script and a call to the first callback function comprises using a closure to store a reference to the first script.

18. The method of claim **1**, wherein the identification of the first script comprises a reference to the first script.

19. The method of claim **1**, wherein, after the call to the first asynchronous API, execution of the first asynchronous API occurs independently of and asynchronously with execution of the first script.

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